U.S. Department
of Transportation
**Federal Aviation
Administration**

Advisory Circular

Subject: TUNDRA TIRES

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Initiated by: ACE-100

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Change:

1. **PURPOSE.** This advisory circular (AC) serves several purposes. First, it summarizes the results of flight tests recommended by the National Transportation Safety Board (NTSB) and conducted by the Federal Aviation Administration (FAA) investigating the effects of tundra tires installed on a Piper PA-18 '150'. Second, it provides information concerning possible hazards associated with the type of operations common for tundra tire users and potential adverse effects of untested installations. Third, it provides general information about the certification process for oversize "tundra" tires, as well as an example "compliance checklist" for the installation of such tires on light airplanes, which have Civil Air Regulations (CAR) Part 3 for a certification basis.

2. **RELATED READING MATERIAL.**

a. 14 CFR Part 23 of the Federal Aviation Regulations, CAR Part 3, and CAR Part 03.

b. National Transportation Safety Board (NTSB) Safety Recommendation A-95-13 dated February 7, 1995.

c. Technical Standard Order (TSO)-C62d, Tires.

d. AC-43.13-1A, Acceptable Methods, Techniques, and Practices - Aircraft Inspection and Repair.

3. **BACKGROUND.** In its Safety Recommendation A-95-13, dated February 7, 1995, the NTSB shared some of their safety concerns about tundra tires with the FAA and requested that the possibility of problems with tundra tires be investigated. The NTSB stated:

> Since the early 1960s, hundreds of airplanes operating in Alaska have been equipped with tundra tires, and dozens of versions of tundra tires--some exceeding 35 inches in diameter--have been marketed. The Safety Board is concerned that field approvals and STCs have been granted for use of these tires without flight test or other data on the aerodynamic effects of the tires and wheels. The Piper PA-18 is the airplane most frequently equipped with tundra tires. The Safety Board believes that the FAA should conduct a demonstration flight test to determine the effects of tundra tires on the PA-18's flight characteristics, including cruise, climb, takeoff, and

landing performance; and, in both straight and turning flight, stall warning and aircraft stability at or near the critical angle of attack. Further, if the tests of the PA-18 indicate the need, the FAA should take corrective action and expand testing to other airplane types equipped with oversized tires.

4. **SUMMARY OF FLIGHT TEST RESULTS FOR PIPER PA-18 '150' EQUIPPED WITH TUNDRA TIRES**. The FAA's flight tests of an airplane equipped with tundra tires and their results are detailed in Appendix 1 to this AC. As can be seen in the report, the tundra tire installations on the Piper PA-18 '150' caused no discernible adverse effects on stall or stall characteristics during the FAA tests. Although there was some degradation of handling qualities associated with increasing the tire size, the effect was not significant with regard to safety. Rate of climb and cruise speed were degraded with the larger tire sizes; however, the aircraft still met certification requirements. Additional tests conducted by an independent Designated Engineering Representative (DER) flight test pilot showed the same lack of effect on stall characteristics with the main landing gear fabric covering removed. It must be remembered that these results are valid only for the Piper PA-18 '150' and for tires no larger than those tested. It should also be noted that although tundra tires did not cause a safety problem, the stall characteristics of the basic Super Cub (and most other airplanes) make low altitude turning stalls hazardous, especially in uncoordinated flight. Also, although washout was not varied during these flight tests, previous FAA experience has shown that stall characteristics are further aggravated when operators of the PA-18 remove the 2.5 degrees of washout at the wing tip, (which is not an approved alteration). This condition will result in a rapid roll when the airplane is stalled during turning flight.

5. **HAZARDS OF OPERATING AIRPLANES LOW AND SLOW**.

a. Although the FAA flight tests showed the effects of tundra tire installations on handling and stall characteristics of the particular model airplane tested were either negligible or within satisfactory limits, it is noted that the type of operations typical to aircraft so equipped represent a potential serious hazard. When flown by an attentive pilot, within legal center of gravity (CG) and weight limits, with sufficient altitude, stalls in the PA-18 are easily recoverable; however, there is no aerodynamic buffet to warn of an impending stall. From the number of low altitude stall/spin accidents which have occurred in these aircraft, it is apparent that pilots are allowing the aircraft to stall with insufficient altitude for recovery during certain operations, such as game spotting. One particularly common type of stall out of a turn experienced by PA-18 and similar light airplanes has been called the "moose-stall" or "wolf-stall."

b. A typical "moose-stall" or "wolf-stall" scenario is as follows: A pilot is circling at a low altitude above an object on the ground with his/her attention focused on that object (instead of on flying the aircraft). Airspeed is slow and bank is steep in an effort to stay in close proximity to the object and keep it in sight. Due to the steep turn the nose tends to drop, which the pilot then subconsciously tries to raise with top rudder (opposite the turn direction). When the critical angle of attack is reached, the airplane stalls abruptly and rolls over the top (in a direction opposite the turn) into a spin entry. This condition can be complicated by winds frequently encountered close to abrupt terrain. A gust could contribute to causing an inadvertent stall, or down drafts could exceed the airplane's climb performance in a turn. The pilot's inattention, the abruptness of the stall, and the low altitude combine to give insufficient warning or time for recovery.

c. These phenomena are not new and have been emphasized in pilot training for years; however, it is apparent that renewed emphasis is warranted. Pilots operating low and slow are taking on additional risks requiring them to devote full attention to flying. Pilots must be thoroughly aware of their airplane's stall and stall warning characteristics, appropriate recovery techniques, and altitude requirements for stall recovery, taking into account bank angles, CG, and operating weight. Also, pilots should be conservative when considering the limitations of their own abilities in relation to a particular flight.

6. AVAILABLE MODIFICATIONS TO IMPROVE THE STALL WARNING AND STALL CHARACTERISTICS OF THE PIPER PA-18 Series.

a. As was mentioned above, Piper PA-18 series airplanes (with or without tundra tires) have no aerodynamic buffet to warn of an impending stall. Given this fact, operators could benefit significantly by installing a stall warning system currently available for the PA-18 series.

b. The warning system mentioned above does nothing to affect the stall itself. Various aerodynamic modifications are available as Supplemental Type Certificates (STC's) for Piper PA-18 series airplanes. Some of these modifications reduce the stall speed, but do nothing to improve the stall characteristics of the airplane. Only a small number of the available aerodynamic modifications significantly improve the stall characteristics of the PA-18 series. One STC demonstrated a dramatic reduction in the tendency for the airplane to snap over the top into a spin entry from a cross-controlled, turning stall. Bush operators in particular could benefit from this installation. Operators are cautioned to determine exactly what, if any, stall characteristic improvements an aerodynamic modification will produce before making a decision to purchase and install it. Also, it should be realized that no modification will lessen the importance of pilot awareness and familiarity with one's airplane.

7. POTENTIAL ADVERSE EFFECTS OF TUNDRA TIRE INSTALLATIONS ON OTHER AIRPLANES.

a. Performance. Tundra tire installations on airplanes other than the Piper PA-18 may produce one or more of the following effects on performance characteristics:

(1) Increased stall speed.

(2) Reduced rate of climb.

(3) Reduced maximum angle of climb.

(4) Reduced maximum level flight speed.

(5) Reduced cruise speed.

(6) Reduced range.

Tundra tires reduce climb, cruise, and range performance more when installed on relatively "clean", well streamlined airplanes than they do when installed on less streamlined airplanes.

b. Flight and Ground Handling Characteristics: Tundra tire installations on airplanes other than the Piper PA-18 may produce one or more of the following effects on handling characteristics:

(1) Reduced ability of brakes to hold against takeoff power.

(2) Reduced brake effectiveness during rejected takeoff and braked landing.

(3) Reduced stability and controllability during rejected or balked landing and go around.

(4) Change in trim range and/or reduced trim authority.

(5) Reduced directional stability and control during takeoff and landing ground rolls, with consequent increased tendency to ground loop.

(6) Increased tendency to nose over during landing.

(7) Reduced stall warning margin, change in aerodynamic stall warning characteristics (warning buffet), and/or reduced effectiveness of stall warning system in both level and turning flight with power on and/or off.

(8) Changes in stalling and stall recovery behavior in both level and turning flight with power on and/or off. Stalls may become more abrupt and altitude loss before recovery may increase.

(9) Increased tendency to enter an inadvertent spin and reduced ability to recover from the spin.

(10) Reduced longitudinal, lateral, and directional stability.

(11) Increase airframe vibration and buffet.

Tundra tires reduce an airplane's directional stability and controllability during takeoff and landing ground rolls, increase its tendency to ground loop during takeoff and landing ground rolls, and increase its tendency to nose over during landing more on paved surfaces than they do on gravel, grass, and other surfaces that allow the tires to skid easily.

8. **CERTIFICATION OF TUNDRA TIRES FOR USE ON LIGHT AIRPLANES**. The certification process for tundra tires is the same as for any other tire to be used in aviation.

a. A manufacturer may obtain a Technical Standard Order Authorization (TSOA) for the tire using the requirements in Technical Standard Order (TSO)-C62d. TSO-C62d contains minimum performance standards for aircraft tires. The TSOA, which covers design and manufacturing of the tire only, is not an installation approval. The tire must be approved for installation on a specific airplane model via Type Certificate (TC) or Supplemental Type Certificate (STC). The applicable requirements for installation of a tire on a given airplane must be determined based upon the original certification basis specified in that airplane's Aircraft Specification or Type Certificate Data Sheet. The development of a compliance checklist, as described in item 9 of this AC, should be accomplished by the applicant together with the FAA engineer.

b. An alternative certification method exists for a tire which does not have a TSOA. In such a case, the tire design approval may be obtained concurrently with the installation approval for specific airplane models via TC or STC. The requirements of the TSO can be used for a determination of acceptable tire performance in such a project. The applicable requirements for installation of a tire on a given airplane must be determined based upon the original certification basis specified in that airplane's Aircraft Specification or Type Certificate Data Sheet. The development of a compliance checklist, as described in item 9 of this AC, should be accomplished by the applicant together with the FAA engineer. Prior to offering tires approved by this method for sale, the tire manufacturer would need a Parts Manufacturing Approval (PMA).

9. **COMPLIANCE CHECKLIST**. See Appendix 2 for an example of the "Compliance Checklist," to CAR Part 3 as amended to November 1, 1949. This checklist is intended to show all aircraft certification requirements that could be affected by a tundra tire installation. Many of these requirements may be unaffected by a given installation. The actual compliance checklist for a specific installation should be determined at the start of a project.

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APPENDIX 1. FAA TEST RESULTS/EFFECTS OF TUNDRA TIRES ON THE HANDLING QUALITIES/STALLS/STALL CHARACTERISTICS OF THE PIPER PA-18

1. Recent accidents in Alaska involving airplanes equipped with tundra tires prompted the National Transportation Safety Board to recommend to the FAA that they conduct flight tests to determine the effects of tundra tires on aircraft performance, stalls, and handling qualities. The following five tires were evaluated at various combinations of center of gravity/weight:

a. Factory installed (8.00-6)

b. McCreary Tundra Tires (8.50-10)

c. McCreary Tundra Tires (29x11.0-10)

d. Schneider Racing Slicks (14.0x32.0x15)

e. Goodyear Airwheels (35x15.0-6)

2. Quantitative/qualitative data obtained from the testing of the four tundra tires were compared to the data obtained from the testing of the factory installed tire. The following is a summary of the findings:

a. Ground Handling. Forward field of view during taxi is inversely related to tire size. As the tire size increases, the ability to see over the nose decreases requiring that the pilot make "S" turns with the airplane. Ground handling during takeoff from a gravel runway is satisfactory for all configurations. Ground handling during landing on a gravel runway is also satisfactory for all configurations tested, although there is a noticeable nose down pitching moment when the tire(s) contact the ground. This is most evident when making a main wheels only landing. Crosswind landings on runway 13 at Lake Hood Strip, a 2,200' x 80' gravel runway next to Lake Hood three miles southwest of Anchorage, Alaska, were demonstrated for tire configurations a, b, and c in winds from 180° (from ahead and to the right of the airplane at an angle of 50° to its flight path) at 14 knots gusting to 16 knots. The wind thus had a crosswind component of approximately 10.7 knots gusting to approximately 12.3 knots and a headwind component of approximately 9.0 knots gusting to approximately 10.3 knots. No crosswinds were available during tests for configurations d and e. No tests for ground handling were accomplished on paved runways. The ground handling characteristics of airplanes equipped with tundra tires are known to be substantially poorer on pavement than on gravel, grass, and other surfaces that allow the tires to skid easily.

b. Performance. Tundra tires adversely affect airplane performance. For example, the uncorrected average rate of climb (tested at 1.05 times maximum gross weight) for the standard tire was 526 feet per minute. The uncorrected average rate of climb for configurations d and e (tested at 1.05 times maximum gross weight) was 449 and 464 feet per minute, respectively.

3. Stalls/Stall Characteristics.

a. The purpose of the stall tests was to determine whether or not there are any differences between the stalling speed and stall characteristics of a PA-18 '150' airplane equipped with tundra tires and the stalling speed and stall characteristics of the same airplane equipped with standard tires. The data obtained from the stall tests do not validate the theory that tundra tires increase the PA-18 '150' stalling speed.

b. Stall characteristics (all configurations) are normal when the airplane is stalled in balanced flight. In a turning stall, the airplane generally rolls slowly to a near wings level attitude. In maneuvering flight, the tendency is for the nose to drop as the bank angle is increased. If the pilot uses top rudder (right rudder in a left turn) to compensate for this and then stalls the airplane, the airplane may roll rapidly over the top. This could result in a departure or the incipient phase of spin. If the airplane is maneuvering at low altitude when this sequence of events occurs (e.g., while circling to spot moose), the airplane may impact the ground prior to recovery. Also, although washout was not varied during these flight tests, previous FAA experience has shown that stall characteristics are further aggravated when operators of the PA-18 remove the 2.5 degrees of washout at the wing tip, (which is not an approved alteration). This condition will result in a rapid roll when the airplane is stalled during turning flight.

4. Handling Qualities. For any given center of gravity/weight, the lateral and directional stability tends to deteriorate as tire size is increased.

5. Stall Warning. Installation of the artificial Stall Warning System on the PA-18 is optional. Most of the PA-18's in Alaska do not have the system installed. The airplane tested did have the artificial Stall Warning System, and a number of test points were obtained with the system deactivated. The airplane as tested does not have an aerodynamic stall warning.

APPENDIX 2. A "COMPLIANCE CHECKLIST" TO CAR PART 3, AS AMENDED TO NOVEMBER 1, 1949

Subpart B--Flight Requirements

Weight Range and Center of Gravity

Section	Subject
3.71	Weight and balance
3.72	Use of ballast
3.73	Empty weight
3.74	Maximum weight
3.75	Minimum weight
3.76	Center of gravity position

Performance Requirements--General

3.81	Performance*
3.82	Definition of stalling speeds*
3.83	Stalling speed*

Takeoff

3.84	Takeoff*

Climb

3.85	Climb*

Landing

3.86	Landing*

Flight Characteristics

3.105	Requirements* (exclude § 3.117)

Ground and Water Characteristics

3.143	Requirements*

Flutter and Vibration

3.159	Flutter and vibration (vibration only)

*** Indicates topics identified by NTSB Safety Recommendation A-95-13**

Subpart C--Strength Requirements

Symmetrical Flight Conditions (Flaps Retracted)

Section	Subject
3.189	Airplane equilibrium

Flaps Extended Flight Conditions

Section	Subject
3.190	Flaps extended flight conditions

Unsymmetrical Flight Conditions

Section	Subject
3.191	Unsymmetrical flight conditions

Control Surface Loads

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3.211	General
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3.213	Trim tab effects

Horizontal Tail Surfaces

Section	Subject
3.214	Horizontal tail surfaces

Vertical Tail Surfaces

Section	Subject
3.219	Maneuvering loads

Control System Loads

Section	Subject
3.231	Primary flight controls and systems

Ground Loads

Section	Subject
3.241	Ground loads
3.242	Design weight
3.243	Load factor for landing conditions

Landing Cases and Attitudes

Section	Subject
3.244	Landing cases and attitudes

Ground Roll Conditions

Section	Subject
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3.249	Side load

Subpart D--Design and Construction

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3.342	Proof of strength

Landing Gear

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3.352	Shock absorption tests
3.353	Limit drop tests
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Wheels and Tires

3.361	Wheels
3.362	Tires

Brakes

3.363	Brakes

Subpart F--EQUIPMENT

Landing Lights

3.699	Landing light installation

Subpart G--OPERATING LIMITATIONS AND INFORMATION

3.735	General

Limitations

3.737	Limitations

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